Gaboury, M. N. 1980.

A report on the 1979 study of brook trout (Salvelinus fontinalis) populations in the lower Nelson River system. Manitoba Department of Natural Resources, Research MS Rep. No. 80-23, 52pp.

ABSTRACT

Anadromous behaviour of Nelson River brook trout (Salvelinus fontinalis) may be limited to a small portion (25%) of the adult population. Based on strontium analyses, trout enter the marine environment at least by age 3+, yet except for ages 4+ and 6+, the sizes of freshwater and anadromous trout were not significantly different.

Trout fry and yearlings inhabit the shallow pools and riffles in the lower reaches of nursery streams, while most juveniles (age 2+ and 3+) and some adults utilize the deeper beaver ponds in the headwaters of streams. Diet of juvenile trout consists of a variety of aquatic insects and minnows. Production of trout between ages 0+ and 3+ in small nursery streams ranged from 1.2 to 11.7 kg/ha/yr. Production was limited by the low number of suitable holding areas for trout during summer and winter. Production of slimy sculpins (Cottus cognatus) in these streams was estimated at 0.4 to 3.4 kg/ha/yr.

The numbers of trout that successfully spawned at Weir River, 5-Mile Hole, and Sky Pilot Creek were smaller than in previous years of the study. The number spawning at 9-Mile Creek was similar to previous years, and some trout had spawned in up to three consecutive years. An

increase in spawners at Wilson Creek was probably due to the removal of the F-pit culvert crossing and a decrease in angling pressure.

Cut-line and borrow pit roads allow anglers easy access to areas where trout congregate to spawn. Planning for the construction of these roads away from rivers is recommended for future hydroelectric dams.

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I. INTRODUCTION

An agreement between Manitoba Hydro and the Department of Natural Resources was initiated in 1976 to study the fisheries resources of the lower Nelson River. Basic study objectives included describing the general biology of brook trout (Salvelinus fontinalis), assessing the effects of hydro-electric development and recommending mitigative measures to protect the fisheries resource. Sampling in 1979 continued in the Long Spruce-Limestone area since a large number of trout were tagged in this area during 1976, 1977 and 1978 (Gaboury 1978), and the trout in three stream populations currently are being affected by construction activities. Streams which had relatively poor catch success two and three years ago were reassessed for trout spawning activity. Streams studied in the Long Spruce-Limestone area included, Wilson and Sky Pilot creeks, and Limestone River. Further sampling was done on the Weir River, the headwaters of a Weir River tributary, the Nelson River mouth, and the coastal waters of Hudson Bay (Figure 1). Study objectives in 1979 were:

1. to investigate headwater lakes of the Limestone and Weir rivers where overwintering brook trout have been caught by area residents
2. to determine the diet, age structure, and timing of movements for brook trout inhabiting the Nelson River estuary
3. to record salinity and temperature profiles for the Nelson River estuary
4. to continue studies at the brook trout spawning areas on the Limestone and Weir rivers, and Sky Pilot and Wilson creeks
5. to provide information on juvenile trout habitat, movements, relative abundance, and diet in the upper reaches of a Weir River tributary and 9-Mile Creek

Figure 3

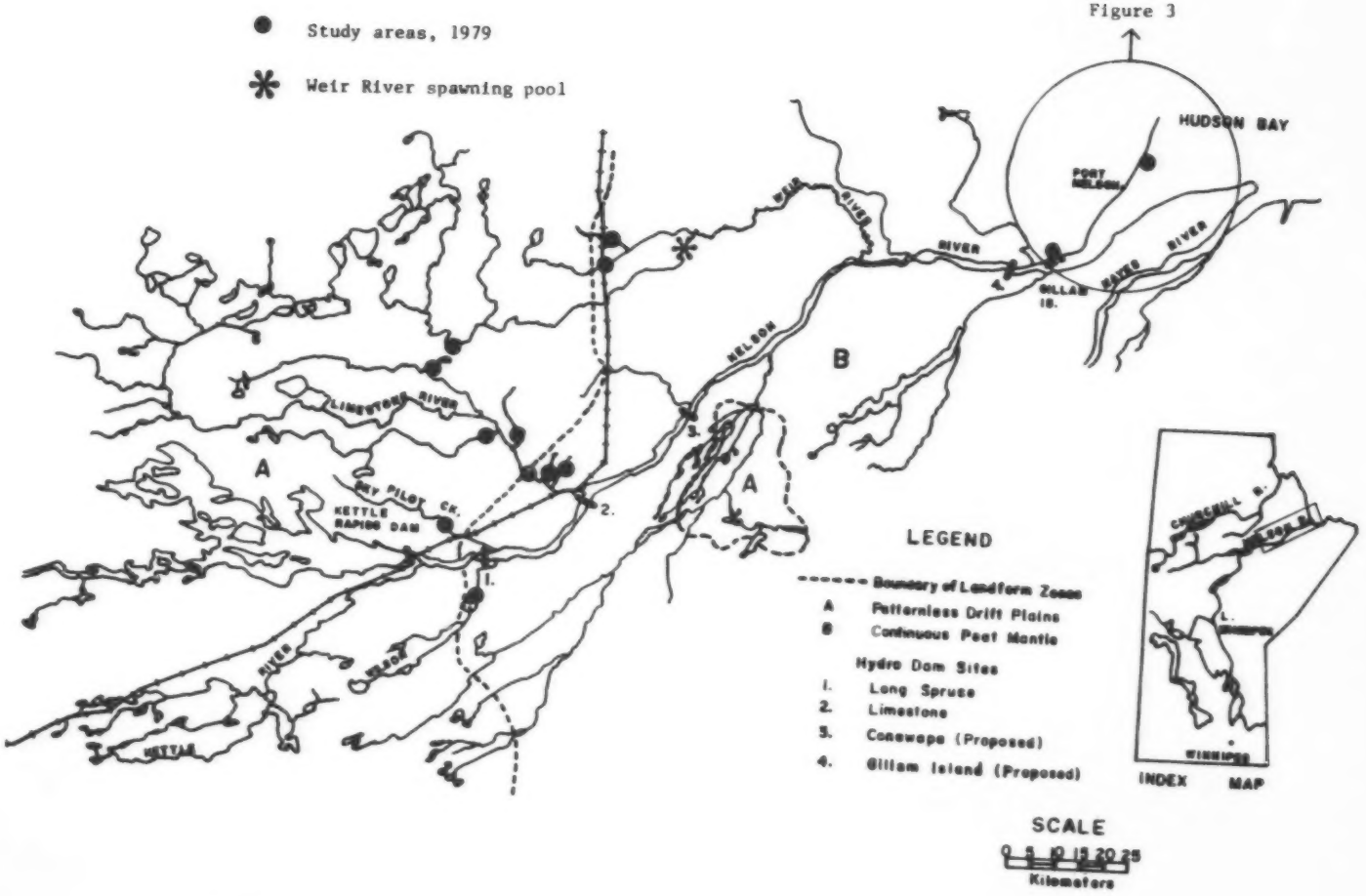


FIGURE 1. Lower Nelson River study area.

6. to estimate fish production in the lower reaches of Gravel Pit and 3-Mile creeks (Limestone River), and
7. to continue observations on the effects of "construction activities" upon the fisheries resources.

II. STUDY AREAS

Location and geography of the lower Nelson River study area were described previously (Gaboury 1978). However, some description is needed of specific locations studied in 1979. Chemical analyses of water samples taken in 1979 from Sky Pilot, Gravel Pit and 3-Mile creeks, and McMillan Lake are given in Table 1.

McMillan Lake is a small, shallow lake located on 18-Mile Creek, Limestone River (Figure 2). The lake has an area of 38 ha, with a maximum depth of 10 m. Pike (Esox lucius) and brook trout inhabit the lake in winter (T. Spence pers. comm.) and summer. Situated 10 km north of McMillan Lake is a lake in the Weir River system (Figure 1). It has a maximum depth of 3 m, with an area of 86 ha. Pike and white sucker (Catostomus commersoni) are present in small numbers. In both lakes, bottom substrate is primarily gravel and silt. Freshwater shrimp (Gammarus sp.) are also abundant in the lakes.

Headwater stream areas of 9-Mile and Gravel Pit creeks, and Weir River are composed primarily of deep (1 to 2 m), silt-bottom beaver ponds. Infrequent riffle areas are predominantly cobble and gravel-bottomed. In low lying areas, channels connecting the ponds flood extensively, encompassing stands of willow (Salix sp.) and alder (Alnus mugosa). Willow/alder are the major shrubs along the shorelines which have a limited amount of overhanging vegetation (Gaboury 1978).

The lower reaches of Gravel Pit and 3-Mile creeks are composed of pool, riffle and shallow channel areas. Bottom substrate is predominantly gravel and cobble with silt overlying gravel in the pools. Physical characteristics of pools and riffles/channels are shown in Table 2. Water temperatures during rotenone treatments in September, 1979 were about 10C. Boulders, overhanging vegetation, undercut banks, and sub-

Table 1. Chemical analyses of water sampled in 1979.

Chemical parameter	Sky Pilot Ck. (Oct. 1) above Nelson River influence	Sky Pilot Ck. (Oct. 1) below Nelson River influence	Gravel Pit Creek (Sept. 6)	3-Mile Ck. (Sept. 6)	McMillan Lake (June 25)
pH	8.2	7.7	7.4	7.2	8.2
conductivity (µmho/cm)	215	221	159	72	215
total hardness ($CaCO_3$, mg/l)	-	-	74	35	115
turbidity (NTU)	2.0	7.0	-	-	-
Ca(Ext.) (mg/l)	-	-	23	10	31
Mg (Ext.) (mg/l)	-	-	4	5	9
Na (Ext.) (mg/l)	-	-	10	10	10
Fe (Ext.) (mg/l)	-	-	0.03	0.03	0.29

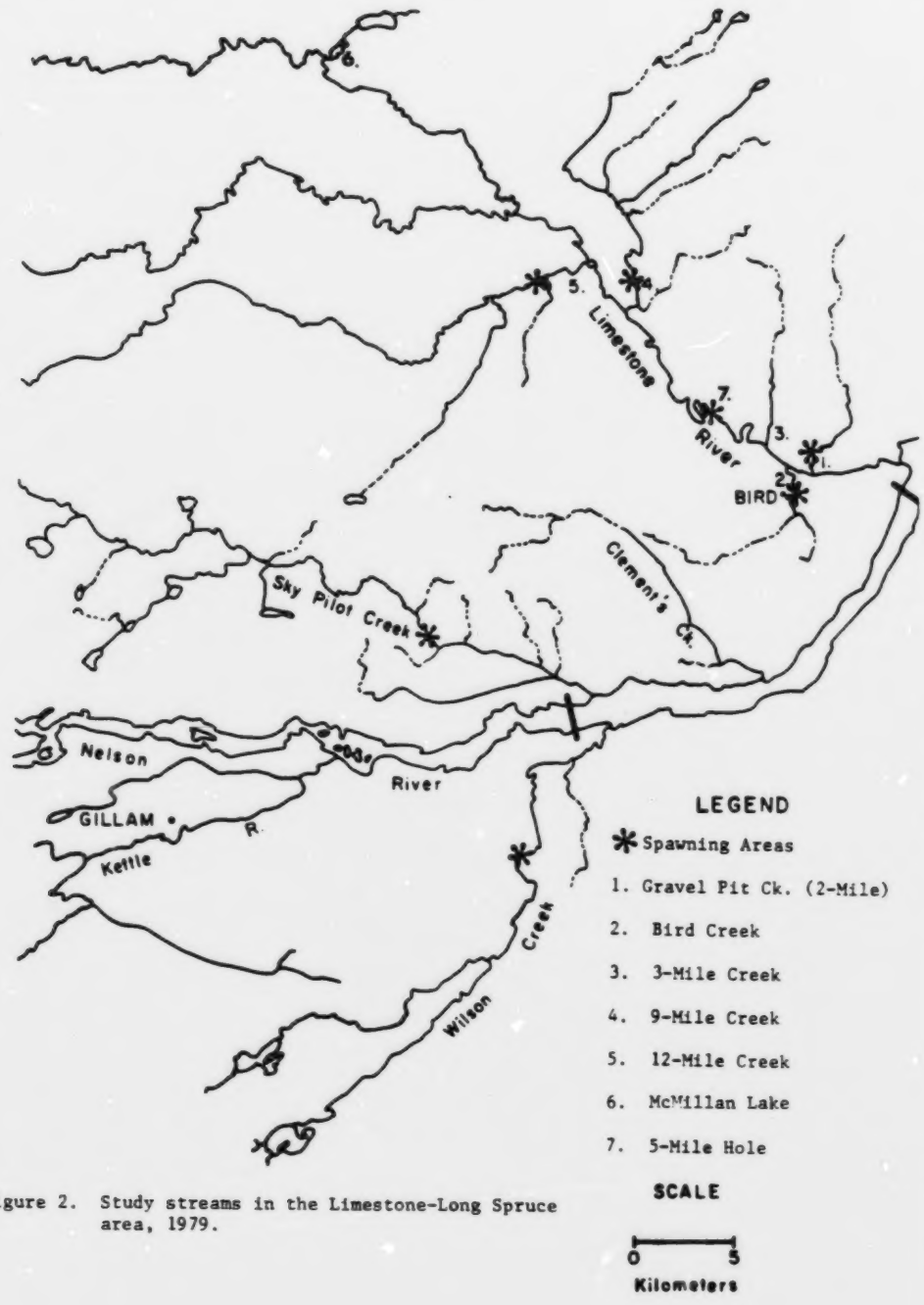


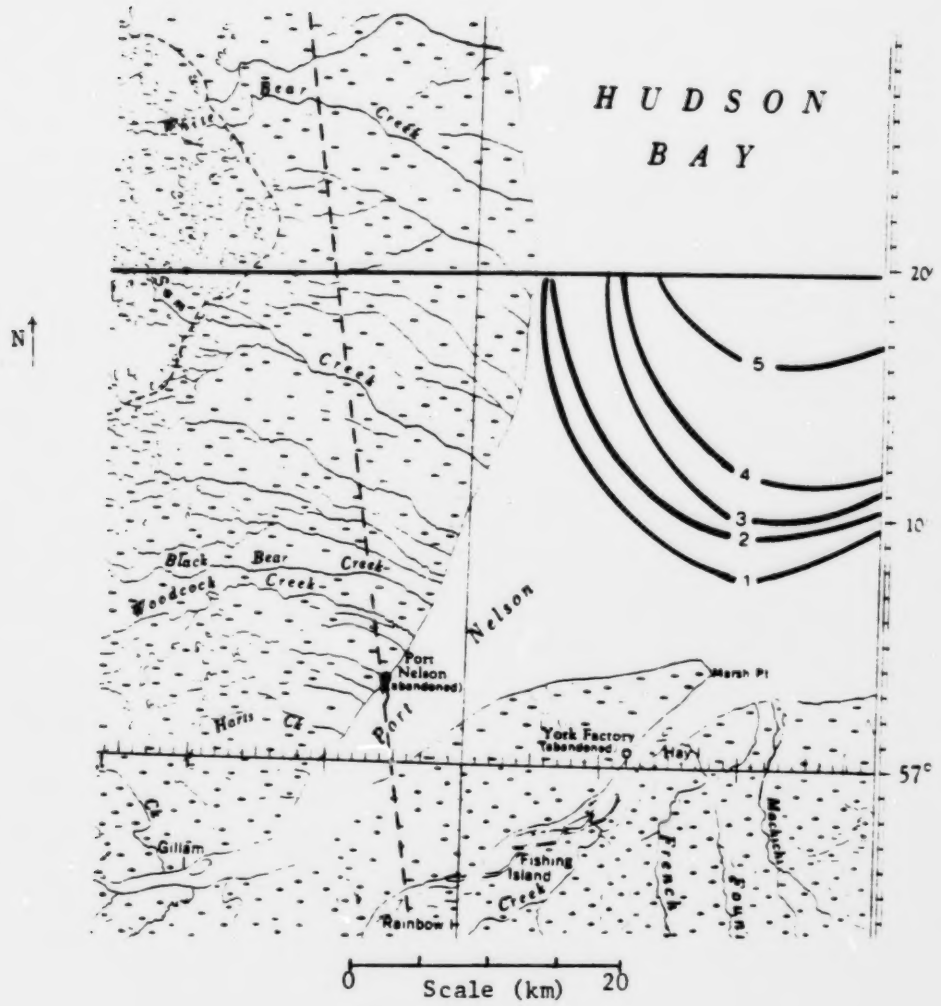
Figure 2. Study streams in the Limestone-Long Spruce area, 1979.

Table 2. Physical characteristics of Gravel Pit and 3-Mile creek study areas.

Characteristic	Gravel Pit Creek Section			3-Mile Creek
	1	2	3	
Total Length (m)	243	705	363	440
Avg. Channel Width (m)	3.2	2.9	3.0	2.5
Avg. Channel Depth (m)	0.7	0.7	0.7	0.5
Channel Length (m)	128	690	40	1440
Channel Area (m^2)	410	2000	120	3660
No. of Pools	3	2	3	2
Avg. Pool Depth (m)	1.5	1.0	2.0	0.8
Total Pool Area (m^2)	1480	110	2010	450
Total Area (m^2)	1890	2110	2130	4050

merged logs provided shelter for trout. Fewer pools occur in the lower reaches of 3-Mile, in comparison to Gravel Pit, yet both creeks above 2 km upstream have large, deep pools with limited riffle areas. Fish species included predominantly brook trout and slimy sculpin (Cottus cognatus) with small numbers of pike, brook stickleback (Culaea inconstans), burbot (Lota lota) and longnose dace (Rhinicthys cataractae).

Salinity and water temperature readings are shown for the Nelson River estuary (Figure 3). Within 20 km northeast of Port Nelson the water appears turbid and brown in colour. Greater than 30 km from Port Nelson the water is clear and light green.



Legend

Contour	Date	Salinity (‰)	Temperature (C)
1	July 6	0	18
2	July 16	3	14
3	July 16	16	11
4	July 16 & 19	23	9
5	July 16 & 19	24	9

Figure 3. Salinity and temperature contours for the Nelson River estuary, 1979. Based on 14 readings with YSI-SCT meter.

III. METHODS

3.1 GENERAL

In 1979, fishing methods and sampling techniques (i.e. length, weight, sex and maturity, ageing, fecundity, and diet) were similar to those described previously (Gaboury 1978). In addition some weir construction was done on 12-Mile Creek, and sections of Gravel Pit and 3-Mile creeks were rotenoned.

3.2 FISH COLLECTION

A single, complete fish collection was made on two streams to assess total fish production. In September, 1979, three stretches of Gravel Pit Creek and the lower 1.5 km of 3-Mile Creek (Limestone River, Figure 2) were treated with Noxfish (S.B. Penick & Co.), a 5% emulsifiable rotenone. Approximately 250 ml of Noxfish were added to 0.2 ha of stream area, giving a concentration of about 0.1 ppm. Dilution in the Limestone River quickly neutralized the rotenone. Fish were collected with dip nets and/or they actively swam into seine (6 mm bar measure) barriers. Most stream areas were relatively shallow, gravel-bottomed with good visibility. Collection was made on foot, moving upstream in the stream. In pools and areas of silty bottom, skin diving gear was used. To be certain most fish were collected, upstream and downstream seines were left in the streams overnight. Collection was then performed again the next day. The fish were preserved in 10% formalin or frozen. In the laboratory general meristic data were recorded for all fish species.

3.3 BIOMASS AND PRODUCTION ESTIMATES

Biomass estimates for slimy sculpin and trout from Gravel Pit and 3-Mile creeks were based on the actual densities and mean weights of fish caught. Since no attempt was made to estimate the population prior to piscicide treatment, compensation was not made for fish densities of those fish poisoned but not captured. Estimates of production for sculpin and trout were made using Ricker's algebraic formulae (Ricker 1946, 1958) and Allen's graphical method (Allen 1951). Production was calculated on an annual basis and expressed as kilograms per hectare per year. Areas of the study sections were calculated from average lengths and widths of channels and pools (Table 2). Information required in the analyses included:

N_i - the density of fish in each group i at the time of collection,

$\overline{w}_i$ - the mean weight in g of each age group i at the time of collection,

B_i - the initial biomass in kg at each age group i at the time of collection which equals $N_i \overline{w}_i / 1000$,

G - the instantaneous growth rate which equals $\log_e \overline{w}_i - \log_e w_i - 1$,

Z - the instantaneous mortality rate which equals $(\log_e N_i - \log_e N_{i-1})$,

H - the rate of increase in biomass which equals G - Z,

$\overline{B}$ - the mean biomass in kg which equals $B_i (e^H - 1)/H$, and

A - the total production in kg which equals $G\overline{B}$.

Although Allen's curve is based on following the change in mean weight and density for one cohort through its life-span, it was necessary to use the various age groups as representative of each interval in the life history. Production was therefore estimated from the curve N_i versus $\bar{w}_i$.

Sculpins were divided into groups based on modes in their length-frequency distribution (Appendix 1). These groups were then assumed to be year classes and used in the production estimates.

In instances where age group densities did not follow a smooth survivorship curve, production rates were calculated from two point moving averages of actual densities and mean weights.

3.4 STRONTIUM ANALYSIS

The analysis for strontium was done on pectoral fin rays from Nelson River system brook trout, Eskimo Point, N.W.T. Arctic char (Salvelinus alpinus), Ekalluk River, N.W.T. Arctic char and chinook salmon, (Oncorhynchus tshawytscha). The fins had been stored dry in a scale envelope bearing details of the fish. The fins were boiled, cleansed of all skin and connective tissues, dried, and the fin rays weighed with up to 200 mg being used. The weighed rays were placed in a 50 ml beaker and digested with 2 ml of perchloric acid and 8 ml of nitric acid. The covered beaker was heated to destroy the organic matter and then the acids were fumed away, leaving a white precipitate. The precipitate was dissolved with 0.1% nitric acid, the exact volume added giving a calcium concentration of 4000 ppm for the solution. It was found that for 100 mg of fin ray material, between 20 to 30 mg of calcium precipitated. Since high concentrations of calcium enhanced the observed amount of

strontium, a minimum calcium concentration of 4000 ppm was maintained in the blank, standard and sample solutions to maximize the strontium concentrations found for each fish. Strontium determinations were made with a Varian Techtron AA6 atomic absorption spectrophotometer utilizing nitrous oxide and acetylene gases. Calcium concentrations were determined with the spectrophotometer utilizing air and acetylene. Methods given in the spectrophotometer handbook for the analysis of strontium and calcium were followed closely. All samples were analyzed by D. Snuggs of the Manitoba Department of Mines.

IV. RESULTS

4.1 GENERAL

In 1979, a total of 740 brook trout were caught, and 85 of these were tagged and released (Appendix 2). The majority of trout were sacrificed to assess fish production in Gravel Pit and 3-Mile creeks.

A χ^2-test of independence on the ages obtained from pectoral and pelvic fin rays, otoliths, and scales of 167 trout, showed no significant difference ($P = 0.05$). Trout ranged in age from 0+ to 9+ years, and in length from 2 to 60 cm (Table 3).

Diet analysis was performed on 98 trout. Coleoptera, Odonata, Hemiptera and fish (minnows, whitefish, or suckers) were the predominant foods (Table 4). Invertebrates and fish were also found in pike stomachs (Table 5), but in Gravel Pit and 3-Mile creeks, three burbot contained slimy sculpin and three had consumed trout fry.

An additional six fecundity determinations were made for trout

Table 3. Growth data of Nelson system brook trout, 1979. Number of fish caught in parentheses.

Area	Age (years)									
	0+	1+	2+	3+	4+	5+	6+	7+	8+	9+
Sky Pilot Creek	-	-	241(3)	288(1)	374(7)	-	-	-	-	-
Limestone River										
-Gravel Pit Ck.	78(227)	131(66)	176(23)	236(58)	270(7)	314(1)	325(1)	-	-	-
-3-Mile Ck.	82(158)	100(4)	161(1)	244(2)	-	-	-	-	-	-
-5-Mile	-	-	300(1)	342(11)	409(30)	447(40)	480(13)	-	-	-
-9-Mile Ck.	26(33)	-	261(2)	319(28)	373(18)	419(7)	479(6)	-	-	-
-12-Mile Ck.	-	-	-	335(1)	400(7)	500(1)	388(1)	414(2)	-	-
-McMillan L.	-	-	-	-	-	-	502(2)	-	-	-
Weir River										
-Main stem	-	-	-	345(1)	431(4)	452(3)	438(1)	600(1)	-	585(1)
-Tributaries	-	-	220(4)	404(1)	-	-	-	-	-	-
Wilson Creek	-	-	-	352(8)	327(1)	473(4)	-	451(1)	-	-
Clement's Creek	76(1)	146(1)	153(2)	222(1)	-	-	-	-	-	-
Nelson River	-	-	-	390(2)	422(5)	426(1)	493(1)	530(1)	-	-

Table 4. Diet analysis of brook trout, 1979. The percentage frequency of each food item is shown for only those stomachs containing food. Numbers in parentheses are the actual number of stomachs containing that food organism.

	Nelson River	Limestone River	Gravel Pit Creek	3-Mile Creek	5-Mile Hole	9-Mile Creek	Weir R. tributary	Clement's Creek
No. of fish examined	10	9	35	3	6	18	5	4
No. of fish with food	7	3	33	3	4	7	3	3
Cl. Hirudinea	57(4)			33(1)				
Araneae			6(2)					
Amphipoda							67(2)	
Cl. Insecta	67(2)							
Hemiptera			27(9)		25(1)	29(2)		
Odonata	33(1)		15(5)	33(1)	75(3)	43(3)	33(1)	67(2)
Plecoptera			3(1)					
Diptera			6(2)	33(1)				
Lepidoptera			6(2)				33(1)	
Coleoptera			45(15)	33(1)		14(1)		
Hymenoptera			9(3)	33(1)				
Cl. Gastropoda			3(1)					
Fish	43(3)		24(8)	33(1)	25(1)	29(2)		33(1)
Insectivora (shrews)						14(1)		

Table 5. Diet analysis of pike, 1979. The percentage frequency of each food item is shown for only those stomachs containing food. Numbers in parentheses are the actual number of stomachs containing that food organism.

	Nelson River	9-Mile Creek	Weir R. tributary	McMillan Lake
No. of fish examined	23	8	34	12
No. of fish with food	17	7	28	8
Hirudinea		14(1)	36(10)	
Amphipoda			36(10)	75(6)
Decapoda	6(1)			
Odonata		100(7)	18(5)	
Ephemeroptera			4(1)	
Fish	94(16)	57(4)	43(12)	25(2)

from the Limestone and Weir rivers (Appendix 3). Observations and data analysis on each of the study areas will be presented in the order in which the study progressed in 1979.

4.2 HEADWATER HABITAT FOR TROUT

4.2.1 Lakes

Two headwater lakes of the Limestone and Weir rivers were surveyed between June 21 and 27, 1979 (Figures 1 and 2). The lake on the Weir River system was devoid of brook trout but two trout (1.5 and 1.7 kg) were caught in McMillan Lake (Limestone River) (Table 3). Ascending fish were cut-off from McMillan Lake by a large beaver dam at the lake outlet. The lake appeared suitable for overwintering trout because of deep water (10 m) at the south-west end. Pike were caught in both lakes and were feeding primarily on Gammarus sp. (Table 5). Surface water temperatures were about 13C.

4.2.2 Streams

To determine the diet, age and growth of brook trout in the upper reaches of streams, Gravel Pit and 9-Mile creeks and three Weir River tributaries were surveyed. Between June 28 and July 1, 35 trout were caught at Gravel Pit Creek. Ages ranged from 2+ to 5+ years, and lengths from 18 to 34 cm. Food items included minnows and a wide variety of invertebrates (Table 4).

In the first week of August, three brook trout ranging in length from 27 to 45 cm and 3+ and 5+ years of age were caught in 9-Mile Creek. One trout (#13623) caught, had been tagged downstream at the spawning pool in 1977 (Appendix 4). Pike also inhabited these slow moving pools. Dragonfly larvae were the predominant

food organisms found in both trout and pike (Tables 4 and 5).

For two weeks in August, gill netting on a Weir River tributary above and below the CNR trestle (Figure 1) resulted in the capture of many longnose suckers (Catostomus catostomus), white suckers, and pike but only two trout. Further netting in ponds of small creeks which flow into the tributary resulted in three trout being sampled. Trout caught in headwater pools were age 2+, between 20 and 23 cm, and had been feeding on Amphipoda (Gammarus sp.), Lepidoptera, and Odonata (Table 4).

4.3 NELSON RIVER MOUTH

Between July 5 and 19, gill netting and angling in the Gillam Island and Port Nelson areas caught only 11 adult trout varying between 35 and 55 cm, and 3+ and 7+ (Table 3). For six of these days, nets were set on tidal flats near the mouths of Woodcock and Black Bear creeks (Figure 3). Salinities in these areas remained at 0 °/oo even during high tides. Considering the frequency of storms in this area, which decrease netting efficiency, fishing success was relatively good. On the average two brook trout, 30 whitefish, and 30 longnose suckers were caught per 100 m of net (stretched mesh: 5 to 10 cm.) The majority of suckers and whitefish were less than 25 cm.

4.4 SPAWNING AREAS

4.4.1 Limestone River

Brook trout spawning activities were monitored at Gravel Pit Creek, 9-Mile Creek, 5-Mile Hole and to a limited extent 12-Mile Creek. In September at Gravel Pit Creek, a spawning area was identified approximately 100 m above the mouth. A total of 11 trout were caught with 10 of these

tagged and released. Fork lengths were between 23 and 33 cm, and ages were 3+ and 4+ years.

At 9-Mile Creek, a total of 67 trout were caught with 46 of these Floy tagged and released(Appendix 2). Eleven previously tagged in either 1976, 1977, or 1978 were recaptured (Appendix 4). The spawning period was similar to that observed for the past three years, occurring in the first three weeks of September. The number of trout spawning in 1979 had declined slightly in comparison to about 100 observed in 1977 and 1978. Male and female trout spawning in up to three consecutive years has been recorded at 9-Mile Creek (Appendix 5). In 1979, individual trout were observed in the spawning pool up to eight days (Appendix 6). Homing accuracy by 9-Mile Creek trout was consistent with previous results (Gaboury 1978). Of the 46 trout tagged at 9-Mile in 1978, seven (15%) returned to 9-Mile in 1979. Also three (2%) of the trout tagged in 1977 and one (0.5%) of those tagged in 1976 homed back to 9-Mile in 1979. Loss of Floy tags may have reduced the observed number of trout returning to 9-Mile. Of the 46 trout tagged at 9-Mile in 1979, nine previously had tags.

Exploitation by local residents in September markedly reduced the number of trout successfully spawning at 5-Mile. Fishing pressure during the summer is moderate since anglers are able to drive within 100 m of the spawning area. During spawning, field staff caught 18 trout and tagged 12 of these. The spawning population was estimated at between 75 and 100 trout, but the removals by domestic fishermen reduced this number by at least 70 per cent. Of the 42 trout tagged at 5-Mile in 1978, none were recaptured here in 1979. However, two recaptures of trout tagged at 9-Mile in 1978 were recorded (Appendix 4). Spawning at 5-Mile occurred, as in 1978, from approximately September 1

to the first week of October.

A fish weir near the mouth of 12-Mile Creek was unsuccessful at capturing trout but caught 48 pike, 19 white suckers, and three whitefish. A snowstorm on September 17 caused high water levels and washed out the traps. Continued high water prevented a reinstallation of the traps. Spawning areas were identified in three locations approximately 6 km above the creek's mouth (Figure 2). Fishing success in the spawning pools in late September was limited since most trout were spent and had moved downstream by this time. Only eight trout were caught and three of these were tagged and released.

4.4.2 Weir River

In 1978, 114 trout out of a total of 168 adults were Floy tagged at the Weir River spawning area. Fishing efforts from September 19 to 27, 1979 resulted in 19 brook trout being captured, and seven of these were tag recaptures. One trout tagged at 5-Mile in 1978 was recaptured in the spawning pool at Weir River in 1979 (Appendix 4). Fly fishing and angling for trout by two parties (each of four fishermen) for a week in late August was also reported to be poor. The total creel taken by the fishermen was two trout, one of these a tag recapture (#13761).

4.4.3 Sky Pilot Creek

Sampling was repeated at Sky Pilot Creek spawning area. Due to high water levels,this area was not studied in 1978. Total catch in 1979 was limited to 11 brook trout (Table 3) with no recaptures of tagged trout from 1976 or 1977. Angling pressure on the creek in 1979 was much lower than in previous years.

4.4.4 Wilson Creek

Gillnetting at Wilson Creek was done in mid-September at a spawning area near F-pit, Long Spruce (Figure 2). A total of 14 trout were caught, with fork lengths between 31 and 57 cm, and ages 3+ to 7+ years (Table 3). Efforts to capture trout here in 1976 and 1977 had been relatively unsuccessful (Gaboury 1978). By late September 1979, illegal fishing by local residents had depleted this spawning stock.

4.5 STANDING CROP AND PRODUCTION

4.5.1 Gravel Pit Creek

Production of trout, based on the total stream area, was approximately 9.0 kg/ha/yr (Ricker's method) with most production occurring in the lowest downstream section (Table 6). Generally, production estimates by Allen's graphical method were on the average 10% larger than Ricker estimates. With a sample of 322 trout, the minimum standing crop was 528 fish or 13.3 kg/ha when all sections were considered. Trout were between 6 and 33 cm long, and ranged in age from 0+ to 4+ years with the main contributors to production being ages 0+ and 1+. Growth of trout was similar in the three sections. Males outnumbered females in each of the sections and a greater percentage of the males were mature.

A total of 623 sculpins were sampled with a minimum standing crop for the total area of 1016 fish or 2.4 kg/ha. Production of sculpins averaged 2.0 kg/ha/yr with most production found in section 3 (Table 7). Sculpins ranged in length from 18 to 113 mm, and were separated into 5 length interval classes. Production and standing crop values in sections 1 and 2 are estimates of yearling and older

Table 6. Standing crop and production of brook trout from Gravel Pit Creek, September 1 to 5, 1979.

Age Group	Section 1		Section 2		Section 3		Total	
	Number	Total weight (g)	Number	Total weight (g)	Number	Total weight (g)	Number	Total weight (g)
0+	113	556.64	88	519.82	17	143.70	218	1,220.16
1+	39	1,044.15	18	413.30	6	180.20	63	1,637.65
2+	11	636.39	3	132.90	1	57.50	15	826.79
3+	12	1,952.10	11	1,703.69	1	140.90	24	3,796.69
4+	-	-	2	628.00	-	-	2	628.00
Production (kg/ha/yr)								
Ricker's method		11.71		9.00		1.67		9.02
Allen's method		13.62		9.92		2.00		10.19
Biomass (kg/ha)		22.16		16.10		2.45		13.23

Table 7. Standing crop and production of slimy sculpins from Gravel Pit Creek, September 1 to 5, 1979.

Length Interval (mm)	Section 1		2		3		Total	
	Number	Total weight (g)	Number	Total weight (g)	Number	Total weight (g)	Number	Total weight (g)
0-35	7	5.46	41	6.15	184	23.92	184	23.92
36-65	75	149.25	57	96.90	153	214.20	286	460.35
66-80	21	108.15	15	62.40	53	258.64	89	429.19
81-95	9	83.79	4	27.98	47	389.16	60	500.83
96-115	2	35.50	-	-	2	24.40	4	59.90
Production (kg/ha/yr)								
Ricker's method		1.14*		0.44*		3.38		2.00
Allen's method		1.38*		0.55*		3.93		1.97
Biomass (kg/ha)		1.99*		0.89*		4.27		2.40

* sculpin fry data excluded from estimate

sculpins since very few fry were caught. Data on sculpin fry were included for section 3 and for the total area production and standing crop estimates.

4.5.2 3-Mile Creek

A total of 165 trout were caught, having a minimum standing crop of 407 fish or 3.6 kg /ha. Production of trout was approximately 2.0 kg/ha/yr (Table 8). Most of the trout production was contributed by fry. In 3-Mile, trout were between 6 and 26 cm, and ranged in years from 0+ to 3+ (Table 3).

For a sample of 121 sculpins, the minimum standing crop was 300 fish or 1.1 kg/ha. Sculpins ranged in size from 24 to 84 mm, and were divided into 4 length interval classes. Production of sculpins was estimated at 0.6 kg/ha/yr (Table 9). Standing crop and production estimates excluded the small number of fry caught.

4.6 STRONTIUM ANALYSIS

For 121 trout from Wilson Creek, and Nelson, Weir and Limestone rivers, strontium concentrations of pectoral fin rays ranged from 0 to 390 µg Sr/g with 28(23%) having values greater than 100 µg Sr/g (Figure 4). Intermediate levels of strontium, between 100 and 480 µg Sr/g, were found for 97 anadromous Arctic char from the Ekalluk River and Eskimo Point, N.W.T. Five chinook salmon had the highest levels, averaging 840 µg Sr/g.

Trout with greater than 100 µg Sr/g were assumed to be anadromous, and trout with less than 100 µg Sr/g were probably non-migratory. Anadromous trout were then tested to determine if they were larger than non-migratory trout. In both groups, mean length

Table 8. Standing crop and production of brook trout from 3-Mile Creek, September 5 and 6, 1979.

Age Group	Number	Total Weight (g)
0+	158	957.13
1+	4	46.70
2+	1	45.40
3+	2	391.00
Production (kg/ha/yr)		
Ricker's method	1.20	
Allen's method	2.45	
Biomass (kg/ha)	3.56	

Table 9. Standing crop and production of slimy sculpin from 3-Mile Creek, September 5 and 6, 1979.

Length Group (mm)	Number	Total Weight (g)
0-35	24	5.09
36-65	60	115.26
66-80	57	313.73
81-95	4	32.80
Production (kg/ha/yr)		
Ricker's method	0.64*	
Allen's method	0.72*	
Biomass (kg/ha)	1.14*	

* sculpin fry data excluded from estimate.

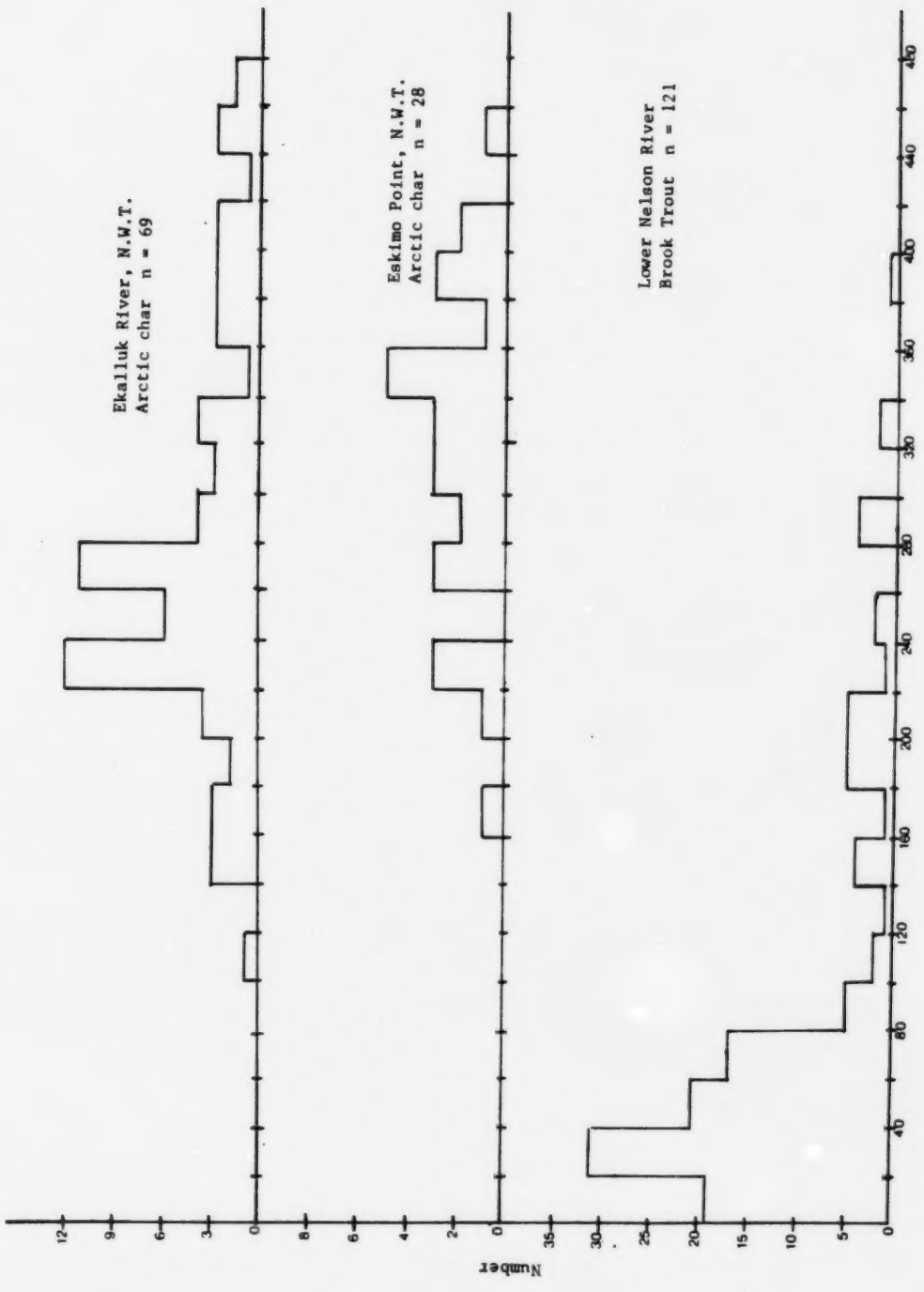


Figure 4. Strontium concentrations for pectoral fin rays from Arctic char and brook trout.

and weight at each age, 3+ to 7+ years, were considered. Length and weight at age 4+, and weight at age 6+ were significantly larger for anadromous trout (Table 10). Also mean strontium concentrations at each age were significantly lower for freshwater trout.

Table 10. Comparison of mean lengths, weights and strontium concentrations between freshwater and anadromous brook trout using a one-tailed t-test, with equal variances and P = 0.05.

Age (yr)	Freshwater				Anadromous				t-values	Significance P = 0.05
	Number	Length (mm)	Weight (g)	µg Sr/g	Number	Length (mm)	Weight (g)	µg Sr/g	1) Length 2) Weight 3) Sr conc.	
3+	20	349	597	35.9	3	366	558	172.3	1) 0.553 2) 0.161 3) 16.115	n.s. n.s. ** p < 0.0005
4+	20	309	850	42.4	9	448	1,189	207.9	1) 2.806 2) 2.883 3) 9.637	* p < 0.005 * p < 0.005 ** p < 0.0005
5+	23	451	1,165	38.4	4	483	1,354	192.7	1) 1.579 2) 1.017 3) 9.114	n.s. n.s. ** p < 0.0005
6+	14	470	1,244	40.7	4	500	1,650	226.7	1) 1.176 2) 2.128 3) 8.550	n.s. * p < 0.025 ** p < 0.0005
7+	10	515	1,703	65.6	5	536	1,950	195.6	1) 0.795 2) 1.181 3) 5.480	n.s. n.s. ** p < 0.0005

V. DISCUSSION

5.1 TROUT HABITAT AND MOVEMENTS

Information on the timing of trout movements and habitat utilization was acquired in 1979 in an effort to describe the life history of brook trout. In an earlier study (Gaboury 1978) it was found that once the brook trout fry are free-swimming, many descend into the larger creeks and/or rivers. Some fry may remain in their natal streams, but very few juvenile and adult trout will overwinter in the small streams because of the limited number of deep pools.

In 1978 and 1979, upstream movements of juvenile trout into streams from creeks and rivers were observed at ice break-up. The maximum size of trout entering the streams is dependent on characteristics of the stream (i.e. number of pools, cover, water depth, and food availability). Generally, trout feeding in streams less than 2 m wide at the outlet tend to be inhabited by trout of age 3+ or less. Within these streams (eg. Gravel Pit, 3-Mile, and Bird creeks), two and three year old trout will feed primarily in beaver ponds in the upper reaches of the stream while brook trout fry and yearlings will be caught in pool-riffle areas in the lower reaches. Streams greater than 5 m wide (eg. 9-Mile, Sky Pilot, Limestone) are utilized by all ages of trout with many of the juveniles overwintering in the streams. In all streams immigration of trout begins in spring and culminates with the spawning run about September 1. Poor spawning runs, as occurred at Weir River in 1979, may be caused by low water levels in August and September, and a rapid decline in water temperature in September. At spawning, small streams may hold older trout for a short period of time. Emigration from smaller streams which do not have adequate

overwintering areas, will occur after spawning. Whereas trout spawning in smaller creeks have finished by the fourth week of September, river spawners (i.e. Weir River and 5-Mile Hole) complete spawning in the third or fourth week of October.

It was suggested that brook trout feed in the coastal waters of Hudson Bay for short periods of time during the summer and thus attain their large sizes (Doan 1948; Gaboury 1978). However, based on fishing efforts at the Nelson River mouth and strontium analysis in the laboratory, it is evident that the majority of large brook trout from the Nelson River tributaries do not utilize the food resources in the Hudson Bay area. Gillnetting for two weeks in July, 1979 resulted in a relatively poor catch of trout. The diet of trout sampled at the Nelson River mouth was composed of freshwater invertebrates and fish. Also not apparent were the brook trout juveniles which could utilize this area for intensive feeding. White (1940) found that anadromous brook trout from the Moser River entered brackish waters at lengths between 170 and 197 mm, and ages 2+ and 3+. Limited utilization of the Nelson River mouth by trout has been observed in 1977, 1978 and 1979.

5.1.1 Strontium Analysis

Strontium analysis can be used to distinguish between sea-run and freshwater fish. Since sea water contains much more strontium than fresh water, sea-run fish will take up more strontium, mainly through their diet (Ophel and Judd 1968), than freshwater fish of the same species. Since its metabolism is similar to that of calcium, strontium tends to be retained by plant and animal tissues (Ophel and Judd 1968; Eisenberg 1973). The amount of strontium taken up is dependent upon

the length of time the fish spends feeding in the sea and/or freshwater (Behrens Yamada et al. 1979), and the types of food eaten (Ophel and Judd 1968). Bagenal et al. (1973) found that the concentrations of scales from freshwater brown trout (Salmo trutta) were below 150 µg Sr./g, and greater than 300 µg Sr/g for sea trout. Moreau and Barbeau (1979) separated anadromous and freshwater lake whitefish by the strontium concentrations of their scales.

By comparison with Arctic char, strontium analysis of pectoral fin rays was used to distinguish sea-run from freshwater Nelson River brook trout. Comparisons of strontium concentrations in pectoral fin rays from both species minimized the discrepancies that may occur if two structures with different degrees of mineralization were used. Twenty-three percent of the Nelson River trout sampled had strontium levels which were similar to sea-run Arctic char from Eskimo Point and the Ekalluk River, N.W.T. Trout with values less than 100 µg Sr/g were assumed to be freshwater residents (Figure 4). Underestimation of the number of freshwater trout was possible, but extension of the upper limit to 140 µg Sr/g would not have affected the results significantly. Although the sizes of Nelson River freshwater and anadromous trout were significantly different at ages 4+ and 6+, the tests were based on small samples of anadromous trout (Table 10). Considering the limited data, test results suggest that the growth rate of anadromous trout was not significantly faster than for freshwater trout.

The validity of the comparison between Arctic char and anadromous trout is based on the assumptions that their utilization of, and diet in fresh and salt waters are similar.

Johnson and Campbell (1975) and Grainger (1953) have determined that Arctic char utilize the sea for two or three months in the summer but return to freshwater to overwinter. A similar movement strategy has been suggested for anadromous Nelson River trout. Johnson and Campbell (1975) found that maturing Arctic char remained in freshwater in the summer prior to spawning. Also, only Arctic char greater than 200 mm were caught moving to sea. A similar length of time feeding, and approximately the same size at migration, would be expected for Nelson River anadromous trout.

Differences in strontium levels in fish appears to be related to their diets. In Perch Lake, Ophel and Judd (1968) found that bullhead (Ictalurus nebulosus) contained almost three times as much strontium as compared to perch (Perca flavescens). Bullhead, an omnivorous species, fed on considerable amounts of aquatic vegetation which contained high levels of strontium (106 to 3890 µg/g). Adult perch consumed primarily fish which have considerably lower strontium concentrations. There is, therefore, a correlation between the strontium concentrations in the fish and in its food.

The diets of Arctic char and brook trout in fresh and salt water appear to be similar. Saunders and Power (1969) reported that char in Matamek Lake, Quebec, ate aquatic insect larvae, small clams, and fish. In the Nelson River tributaries, brook trout diet was predominantly aquatic insects (larva, nymph, and adult) and fish.

In the sea, White (1942) found that brook trout fed largely upon small fishes and Crustacea. Capelin (Mallotus villosus)

were found in an Arctic char returning to Nauyuk Lake (Johnson and Campbell 1975). Grainger (1953) found invertebrates, primarily amphipods and mysids, and fishes including sculpins, lumpfishes, seasnails, and Arctic char were eaten by Arctic char from Frobisher Bay, N.W.T. With similar forage fishes being available for Nelson River trout and Eskimo Point char in Hudson Bay, strontium concentrations of the two species would be comparable. The range of strontium values for Ekalluk River char include those for Eskimo Point char, suggesting similar diets. Since anadromous char and trout spend only a short period each year feeding in salt water, and because both feed extensively in freshwater, their strontium concentrations were lower than for adult chinook salmon (276 µg/g versus 840 µg/g).

Silver colouration, typical of sea-run trout (White 1940; Wilder 1952), did not connote high levels of strontium (>100 µg/g) for Nelson River system trout. Based on strontium analysis, six silver trout were categorized as non-migratory. White (1940) noted that salmon and brook trout became silvery before migrating to the sea. Wilder (1952) found strictly freshwater brook trout in Boggy Lake and Lake Ainslie which were distinctly silvery. It does not appear possible then to accurately discriminate between sea-run and non-migratory trout on the basis of colour.

Therefore, with strontium analysis it was found that only a portion of the Nelson River trout population are anadromous, and that growth of Nelson River trout in fresh and salt water is similar. It is possible then that trout could attain large sizes in streams above the hydro dams. However if there was movement into the lower Nelson River reservoirs the trout would be vulnerable to predation by pike. Although the incidence of trout moving into salt water appears to be low,

this does not preclude the possibility of feeding and spawning migrations between the Nelson River mouth and its tributaries.

5.2 PRODUCTION

The purpose of the study on the Limestone tributaries was to determine the utilization of the smaller creeks by trout and the level of fish production. In Gravel Pit Creek, section 1 had the highest trout density and production resulting from relatively good pool and riffle habitat, and cover in the form of submerged logs and overhanging willows. In section 2, cover was sufficient but with 2 small pools, holding areas for trout were reduced resulting in lower production in comparison to section 1. Section 3 had the lowest trout density and production which may be caused by the limited amount of riffle areas and predominance of beaver ponds with slow moving water. It is interesting to find the highest sculpin production in section 3. Competition for food between trout and sculpins may limit their absolute abundances. Koster (1937) noted that since sculpins and smaller trout are dependent on the small bottom fauna, competition with sculpins is significant in nursery streams. Gravel Pit and 3-Mile creeks would be considered as nursery streams for trout. Stream habitats in 3-Mile Creek and section 2, Gravel Pit Creek were alike. In both of these sections the densities of trout fry were about 400/ha and estimates of sculpin production were similar.

Production in 3-Mile Creek was limited by the lack of suitable holding areas for yearlings and older trout. Growth of 3-Mile trout was similar to Gravel Pit trout (Table 3).

Production estimates for brook trout and sculpins must be considered with some limitations. Since the fish collection was made in September, and without data on trout fry mortality and emigration, it was not possible to accurately extrapolate back to the number of fry upon emergence. Production in this period was omitted in the estimates. Hunt (1966) showed that 32 to 46 per cent of production by a year class of brook trout was contributed in the first year. O'Connor and Power (1976) found that fry contributed between 26 and 48 per cent to the brook trout production of Matamek streams. Trout production values for the Limestone streams could have been underestimated by as much as 50 per cent. The maximum trout production would then have been about 22 kg/ha/yr.

In the small Limestone streams, emigration and immigration of trout occurs primarily in spring and fall. During the spring freshet, emigration of trout fry and immigration of juvenile and adult trout occurs. Fry emigration would cause an underestimation of the potential production of the stream, while trout immigration may not affect production estimates significantly. Since trout densities appear limited by the number of adequate holding areas, similar numbers of trout would be expected to immigrate into the streams each spring. However, without quantitative data on migrations it is not possible to conclude that the number of fish caught are representative of each creek's population. During the fall, immigration of adult spawners would affect biomass more than production estimates since most of the trout that were ready to spawn were age 3+ or older.

Production estimates of trout must be considered as underestimations of the actual rates. However as estimates for yearling and older trout they may be close approximations of the amount of fish tissue these streams can produce.

Similarly for sculpins, production during the first year could not be included in the estimates. Also, a complete collection of sculpin fry was not possible because of their small size and negative buoyancy under stress. Where a small number of fry were captured, this was probably an underestimation of their abundance. These data were therefore omitted from production and biomass estimates. Sculpin production estimates for the Limestone streams should be considered as approximations for fish assumed to be age 2+ and older. Petrosky and Waters (1975) found that sculpins in their first and second (1+) years contributed 65 and 20 per cent to total production. Production of age 2+ and older slimy sculpins in a small Minnesota brook trout stream (Petrosky and Waters 1975) was better than for the Limestone streams (8.8 versus 1.2 kg/ha/yr).

If a comparison is made with other production studies on brook trout (Table 11), and taking into account the limitations of this study, it is evident that the Limestone streams have the lowest trout production. With an abundance of holding areas for the Lawrence Creek population, Hunt (1966) found higher densities of fry and yearlings with faster growth rates, than were found for Limestone trout. These two age groups contributed 82 per cent of the total Lawrence Creek production. Although the growth of Limestone trout is apparently faster than for the Matamek trout (O'Connor and Power 1976), fish density and production is lower in the Limestone area. Since production is ultimately regulated by growth and numerical abundance, fish density would appear to be limiting production in the Limestone area. Trout density in the Limestone streams appears to be governed by the number of suitable holding areas during the summer and winter. Beaver ponds with slow moving water are used to a limited extent while the pool and riffle habitat is

Table 11. Brook trout production (kg/ha/yr) in various streams.

Stream	Production	Reference
Lawrence Creek, Wis.	93-106	Hunt 1966
Matamek streams, Que.	14- 66	O'Connor and Power 1976
Gravel Pit Creek, Man.	1.7-11.7	
3-Mile Creek	1.2	

preferred. The apparent low number of pool/riffle areas may cause emigration from the small creeks and/or high mortality during the winter.

Habitat improvement to increase trout production (Hunt 1969) may be a mitigative measure which should be considered for some streams above the hydro dams.

5.3 CONSTRUCTION ACTIVITIES

It was observed that cut-line roads near the Limestone River allowed anglers easier access to 5-Mile, 9-Mile and 12-Mile where concentrations of trout were found. This has resulted in a dramatic increase in the exploitation of trout stocks. Similarly, borrow pit roads allowed anglers access to the Sky Pilot and Wilson spawning areas (Gaboury 1978). Therefore it is recommended that future dam construction should not include cut-line and borrow pit roads paralleling creeks and rivers.

In the spring of 1979, leakage from the north side of the Long Spruce reservoir was caused by structural weaknesses in the dike in areas where the permafrost had melted. To rectify the immediate situation, Manitoba Hydro channeled the water through a series of weirs into Sky Pilot Creek. If trout use olfaction to home to their parent stream, dilution and changes in water chemistry (Table 1) of Sky Pilot Creek probably did not affect the trout's ability to recognize their home stream. Minimum threshold concentrations of home stream waters were recognized by sockeye salmon (Oncorhynchus nerka) in 10 to 25 $^{o}/oo$ (Harden Jones 1968) which is substantially less than what would be expected for the diluted Sky Pilot waters entering the Nelson River. However, these leaks in Long Spruce reservoir, on the north and south sides, can cause extensive erosion of sand and silt into the lower reaches of Wilson and Sky Pilot creeks. If it recurs, this problem would result in siltation of the stream bed, increased turbidity, destruction of some stream banks, with perhaps declines in abundance of benthic fauna, and in the number of holding areas for trout.

The apparent increase in spawners at F-pit, Wilson Creek, was probably due to the removal of an inadequate culvert below the

spawning area, and the reduction in hydro construction workers decreasing angler exploitation on all streams in 1979.

VI. SUMMARY AND CONCLUSIONS

1. Anadromous behaviour of brook trout may be limited to a small portion (25%) of the adult population.
2. Except for ages 4+ and 6+, freshwater and anadromous trout were not significantly different in size.
3. Anadromous trout will have entered the marine environment at least by age 3+.
4. Coastal areas near Port Nelson appear to be utilized to a limited extent by trout, but longnose suckers and whitefish were abundant.
5. Trout fry and yearlings inhabit the shallow pools and riffles in the lower reaches of nursery streams.
6. Juveniles (ages 2+ and 3+) and some adult trout utilize the deeper beaver ponds in the headwaters of streams.
7. Production of trout between ages 0+ and 3+ in small nursery streams ranged from 1.2 to 11.7 kg/ha/yr.
8. Production of slimy sculpins in these streams was estimated at 0.4 to 3.4 kg/ha/yr.
9. Fewer trout successfully spawned at Weir River, 5-Mile, and Sky Pilot Creek than during previous years.
10. Spawning in up to 3 consecutive years has been recorded for 9-Mile trout.
11. Removal of the F-pit culvert crossing and a decrease in angling pressure has resulted in an increase in spawners at Wilson Creek.
12. Cut-line and borrow pit roads allow anglers easy access to spawning areas where excessive fishing pressure is detrimental to trout stocks.
13. Leakage from the Long Spruce reservoir caused extensive erosion of sand, with some siltation of the lower reaches of Sky Pilot and Wilson creeks.

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Appendix 1. Length frequency data for slimy sculpin from Gravel Pit and 3-Mile creeks, 1979.

Fork Length Interval (mm)	Frequency (No.)	
	Gravel Pit	3-Mile
16-20	2	-
21-25	218	1
26-30	9	21
31-35	3	2
36-40	3	-
41-45	40	3
46-50	88	24
51-55	78	14
56-60	44	12
61-65	33	7
66-70	31	16
71-75	37	18
76-80	21	23
81-85	30	4
86-90	25	-
91-95	5	-
96-100	1	-
101-105	1	-
106-110	1	-
111-115	1	-
Total Number	671	145

Appendix 2. Floy tagging summary for the lower Nelson study, June-October, 1979.

Tagging Location	Tag Numbers	Total Tagged	Total Recaptured (year)
Limestone River	07636-07640	8	0(1979)
9-Mile Creek	07642-07644		
proper (except spawning pool)			
spawning pool	07626-07635	38	7(1979)
	07645-07672		
5-Mile Hole	07601	12	1(1979)
	07676-07686		
12-Mile Creek	07673,07675, 07760	3	0(1979)
Gravel Pit Creek	07588,07589	10	3(1979)
	07592-07597		
	07599,07600		
Sky Pilot Creek spawning pool	12715-12722	8	0(1979)
Wilson Creek spawning pool	12707-12714	8	0(1979)
Weir River	13965-13970	10	2(1979)
spawning pool	13972-13975		

Appendix 3. Fecundity determinations for 6 brook trout from the Limestone and Weir rivers, 1979.

Area	Identification Number	Length (mm)	Weight (g)	Egg Diameter (mm)	Number of Eggs
Limestone River	151	328	400	3.4	808
	158	440	1000	4.5	2391
	160	455	1175	3.8	2989
	162	360	650	3.6	1685
	202	266	239	3.5	581
Weir River	13671	420	1000	4.2	2693

Appendix 4. Recapture data for trout tagged in 1976, 1977 and 1978, and recaptured in 1979.

Tag Number	Tagging Location	Tagging Date Day/Month/Year	Recapture Location	Recapture Date
13553	9-Mile Creek -spawning pool	15/09/76	9-Mile Creek -spawning pool	13/09/79
			"	14/09/79
13384	9-Mile Creek -lower 2.5 km	27/08/77	"	13/09/79
			"	15/09/79
13399	"	31/08/77	"	15/09/79
13623	9-Mile Creek -spawning pool	07/09/77	9-Mile Creek -20 km upstream	04/08/79
13422	Gravel Pit Creek	16/05/77	9-Mile Creek -spawning pool	14/09/79
13255	9-Mile Creek -spawning pool	08/09/78	"	13/09/79
			"	19/09/79
13256	"	08/09/78	9-Mile Creek -lower 2.5 km	09/09/79
13261	"	08/09/78	"	09/09/79
13263	"	08/09/78	"	09/09/79
13276	"	09/09/78	9-Mile Creek -spawning pool	19/09/79
13288	"	09/09/78	5-Mile	14/09/79
13293	9-Mile Creek -spawning pool	10/09/78	9-Mile Creek -spawning pool	13/09/79
07548	"	14/09/78	9-Mile Creek -lower 2.5 km	09/09/79
07549	"	14/09/78	5-Mile	21/09/79
07586	5-Mile	22/09/78	Weir River -spawning pool	26/09/79
13667	Weir River -spawning pool	05/08/78	"	20/09/79
			"	25/09/79
13761	"	15/09/78	"	23/08/79
13816	"	26/09/78	"	22/09/79
13671	Weir River -near tributary	12/08/78	"	20/09/79

Appendix 5. Evidence of repeat spawning for Nelson River trout.

Tag Numbers	Tagging Location	Tagging date (Day/Month/Year)	Recapture Location	Recapture Date	Sex
13408	9-Mile Creek -lower 2.5 km	07/08/76	9-Mile Creek -spawning pool	04/09/77	female
			"	08/09/78	
13439	"	29/08/76	"	07/09/77	female
			"	09/09/77	
			-lower 2.5 km	14/09/77	
13494	-spawning pool	08/09/76	-spawning pool	06/09/77	female
			"	09/09/77	
			"	09/09/78	
13488	"	08/09/76	-mouth	26/08/77	male
			-spawning pool	01/09/77	
13497	"	08/09/76	"	08/09/77	male
			"	09/09/77	
13506	"	09/09/76	-lower 2.5 km	27/08/77	male
			"	30/08/77	
13512	"	09/09/76	"	29/06/77	male
			"	09/07/77	
13523	"	09/09/76	9-Mile Creek -spawning pool	01/09/77	female
			"	03/09/77	
			"	05/09/77	
			"	07/09/77	
			"	08/09/78	
13552	"	15/09/76	"	04/09/77	male
			"	08/09/78	
13553	"	15/09/76	-lower 2.5 km	30/08/77	female
			-spawning pool	08/09/77	
13568	-mouth	17/09/76	"	18/07/77	female
13571	-spawning pool	19/09/76	"	07/09/77	female
			"	10/09/78	
13574	-lower 2.5 km	19/09/76	-lower 2.5 km	03/09/77	female
			-spawning pool	13/09/77	
13682	-mouth	08/07/77	"	05/09/77	male
			"	08/09/78	

Appendix 5 cont.

Tag Numbers	Tagging Location	Tagging date (Day/Month/Year)	Recapture Location	Recapture Date	Sex
13384	9-Mile Creek -lower 2.5 km	27/08/77	9-Mile Creek -spawning pool	31/08/77	male
			"	08/09/78	
			"	13/09/79	
13385	"	30/08/77	"	08/09/78	female
13399	"	31/08/77	"	04/09/78	male
			"	09/09/78	
			"	19/09/79	
13342	"	02/09/77	"	12/09/77	female
			-lower 2.5 km	09/09/78	
13614	-spawning pool	06/09/77	-spawning pool	07/09/77	female
			"	09/09/78	
13616	"	07/09/77	"	08/09/78	male
13621	"	07/09/77	"	18/09/77	female
			"	09/09/78	
13623	"	07/09/77	"	08/09/78	male
			"	10/09/78	
13640	"	09/09/77	"	12/09/77	male
			"	08/09/78	
13645	9-Mile Creek -lower 2.5 km	10/09/77	9-Mile Creek -spawning pool	08/09/78	female
13647	-mouth	11/09/77	"	08/09/78	female
13255	-spawning pool	08/09/78	"	13/09/79	male
13256	-spawning pool	08/09/78	-lower 2.5 km	09/09/78	male
13263	"	08/09/78	"	09/09/79	female
13276	"	09/09/78	-spawning pool	19/09/79	male
07548	"	14/09/78	-lower 2.5 km	09/09/79	female
07549	"	14/09/78	5-Mile Hole	21/09/79	female
13667	Weir River -spawning pool	05/08/78	Weir River -spawning pool	20/09/79	female
			"	25/09/79	
13816	"	26/09/78	"	22/09/79	male

Appendix 6. Recapture data for trout tagged and recaptured in 1979.

Tag Numbers	Tagging Location	Tagging Date Day/Month/Year	Recapture Location	Recapture Date
07633	9-Mile Creek -spawning pool	08/09/79	9-Mile Creek -spawning pool	14/09/79
			-mouth	14/09/79
07635	"	08/09/79	9-Mile Creek -spawning pool	14/09/79
			"	15/09/79
07655	"	13/09/79	"	19/09/79
07657	"	13/09/79	"	19/09/79
07661	"	14/09/79	"	14/09/79
07668	"	14/09/79	"	19/09/79
07669	"	14/09/79	"	19/09/79
07601	5-Mile	07/09/79	5-Mile	25/09/79
07589	Gravel Pit Creek	28/09/79	Gravel Pit Creek	29/09/79
07593	"	28/09/79	"	29/09/79
07594	"	28/09/79	"	29/09/79
13966	Weir River -spawning pool	20/09/79	Weir River -spawning pool	21/09/79
13967	"	20/09/79	"	21/09/79